

## **Pump Device**

### **Claims**

1. Pump device (1) for the hydraulic actuation of a valve (2), in particular used in the production of crude oil or natural gas, such as a safety valve assigned to a pipeline or a tree, with a piston-cylinder unit (3) from which hydraulic fluid (4) can be pumped in the direction of the valve (2) under pressure,  
**characterised in that**  
an electrical drive device (5) is movably connected to the piston (61) of the piston-cylinder unit (3) for its alternating movement in the piston longitudinal direction (62) inside the cylinder (63).
2. Pump device according to Claim 1,  
**characterised in that**  
the electrical drive device (5) exhibits a spindle drive (6), a reduction gear (7), a spur gear (8) and at least one drive shaft (21) with at least one electric motor (9) rotating it.
3. Pump device according to Claim 1 or 2,  
**characterised in that**  
the spindle drive (6) exhibits a rotatable, but axially immovable spindle nut (10) and an axially movable threaded spindle (11).
4. Pump device according to one of the previous Claims,  
**characterised in that**  
the threaded spindle (11) is releasably connected at its actuating end (12) to the piston (61).
5. Pump device according to one of the previous Claims,  
**characterised in that**  
the spindle nut (10) is movably connected to the reduction gear (7) which is formed, especially as a so-called harmonic drive gear (13).

6. Pump device according to one of the previous Claims,  
**characterised in that**  
the spindle nut (10) is rotationally rigidly connected to a flexible, cup-shaped toothed sleeve (14) of the harmonic drive gear (13).
7. Pump device according to one of the previous Claims,  
**characterised in that**  
a rotating sleeve (15), which is rotationally rigidly connected at one end (16) to the toothed sleeve (14) and at its other end (17) to the spindle nut (10), is arranged between the toothed sleeve (15) and the spindle nut (10).
8. Pump device according to one of the previous Claims,  
**characterised in that**  
a wave generator (18) of the harmonic drive gear (13) is rotationally rigidly connected to a first spur wheel (19) of the especially helically toothed spur gear (8), whereby a second spur wheel (20) is rotationally rigidly arranged on the drive shaft (21) driven by the motor.
9. Pump device according to one of the previous Claims,  
**characterised in that**  
the spur gear (8) is a double helical gear (22).
10. Pump device according to one of the previous Claims,  
**characterised in that**  
the piston (61) is adjustably supported in a piston chamber (23) of the cylinder (63) in the piston longitudinal direction (62), whereby the piston chamber (23) exhibits on its face side (25) at least one suction and one discharge hole (26, 27).
11. Pump device according to one of the previous Claims,  
**characterised in that**  
each hole (26, 27) is assigned a non-return valve (28, 29), which is subjected to a force opposite to the hydraulic fluid flow direction through the respective hole (26, 28).

12. Pump device according to one of the previous Claims,  
**characterised in that**  
the hole (27, 28) is formed in a cylinder bottom plate (30), especially releasably fixed on the cylinder (63).
13. Pump device according to one of the previous Claims,  
**characterised in that**  
the suction hole (26) opens into an intermediate reservoir (31) of the pump device (1) with its end (32) facing away from the piston (61).
14. Pump device according to one of the previous Claims,  
**characterised in that**  
a feed pipe (33) for the hydraulic fluid opens into the intermediate reservoir (31).
15. Pump device according to one of the previous Claims,  
**characterised in that**  
the discharge hole (27) is connected to a discharge pipe (34) for the passage of the hydraulic fluid in the direction of the valve (2).
16. Pump device according to one of the previous Claims,  
**characterised in that**  
the discharge pipe (34) is brought out through the intermediate reservoir (31) from a pump housing (35).
17. Pump device according to one of the previous Claims,  
**characterised in that**  
a connecting pipe (36) branches from the discharge pipe (34) for the connection of an accumulator (37).
18. Pump device according to one of the previous Claims,  
**characterised in that**  
the accumulator (37) comprises a pressure storage means in particular in the form of Belleville springs.

19. Pump device according to one of the previous Claims,  
**characterised in that**  
at least one branch pipe (39, 40) branches from the discharge pipe (34) and / or the discharge hole (27).
20. Pump device according to one of the previous Claims,  
**characterised in that**  
a first branch pipe (39) leads to a pressure switch (41).
21. Pump device according to one of the previous Claims,  
**characterised in that**  
on reaching a predetermined hydraulic fluid pressure in the first branch pipe (39) the pressure switch (41) outputs an electrical control signal for opening a safety valve (42).
22. Pump device according to one of the previous Claims,  
**characterised in that**  
the safety valve (42) is arranged in a second branch pipe (40).
23. Pump device according to one of the previous Claims,  
**characterised in that**  
the safety valve (42) is formed as a mechanically actuatable non-return valve (43).
24. Pump device according to one of the previous Claims,  
**characterised in that**  
the electrical control signal can be transferred to an electric servomotor (44), in particular a stepper motor, through which the safety valve (42) can be mechanically actuated.
25. Pump device according to one of the previous Claims,  
**characterised in that**  
a pinion (45) is drive-connected to the servomotor (44), the said pinion (45) being rotationally connected to a cam disc (46), whereby an actuating plunger (47) of the safety valve (42) is in contact with the cam disc (46).
26. Pump device according to one of the previous Claims,

**characterised in that**

the cam disc (46) exhibits at least an actuating cam (48) along its circumference.

27. Pump device according to one of the previous Claims,  
**characterised in that**  
the actuating plunger (47) is a roller plunger (49), which with its roller (50) is in rolling contact with a circumferential surface (51) of the cam disc (46).
28. Pump device according to one of the previous Claims,  
**characterised in that**  
the roller plunger (49) is subject to spring pressure in the direction of the cam disc (46).
29. Pump device according to one of the previous Claims,  
**characterised in that**  
the cam disc (46) and / or the servomotor (44) is assigned an automatic reverse rotation device (52) for the reverse rotation of the cam disc (46).
30. Pump device according to one of the previous Claims,  
**characterised in that**  
a wound or spiral spring (53), similar to a clockwork spring, is assigned to the servomotor (44) as a reverse rotation device (52), which can be transferred by actuation of the servomotor for opening the safety valve (42) from its essentially destressed state into a stressed state.
31. Pump device according to one of the previous Claims,  
**characterised in that**  
the wound / spiral spring (53) is drive connected on the rear side (54) of the servomotor (44) facing away from the pinion (45) to the servomotor.
32. Pump device according to one of the previous Claims,  
**characterised in that**  
a feedback pipe (55) for the feedback of the hydraulic fluid when the safety valve (42) is open runs from the safety valve to the intermediate reservoir (31).

33. Pump device according to one of the previous Claims,  
**characterised in that**  
the pump device (1) is of modular construction.
34. Pump device according to one of the previous Claims,  
**characterised in that**  
the cam disc (46) is rotationally supported on an external circumference (56) of the rotating sleeve (15).
35. Pump device according to one of the previous Claims,  
**characterised in that**  
a quick-release coupling device (57) is arranged between the pump housing (35) and the hydraulic fluid supply pipe (58).
36. Pump device according to one of the previous Claims,  
**characterised in that**  
at least two servomotors (44, 59) are arranged redundantly with respect to one another.
37. Pump device according to one of the previous Claims,  
**characterised in that**  
the hydraulic fluid is an injection fluid, in particular an inhibitor.
38. Pump device according to one of the previous Claims,  
**characterised in that**  
a position sensor (60) is assigned to at least the threaded spindle (11).